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(71) Applicant: Tri-State Oil Tool (UK), a division of Baker Hughes Limited
Kirkhill Road, Kirkhill Industrial Estate, Dyce
Aberdeen AB2 0ES(GB)

(72) Inventor: Doig, Thomas, c/o Tri-State Oil Tool,
Baker Hughes
Int. Netherlands BV PO Box 47
Nijverhedesdraat 12
NL-1700 AA Heerhugowaard(NL)
Inventor: Murray, Kenneth Alexander
26 Nether Black Hall, Inverurie
Aberdeen, Scotland(GB)

(74) Representative: Pacitti, Pierpaolo Alfonso M.E. et al
Ian G. Murgitroyd and Company Mitchell House 333 Bath Street
Glasgow G2 4ER(GB)

(54) Metal seal casing patch.

(57) A patch for oil-well casing has a metal-to-metal seal formed by a seal ring (20) forced against a casing stub (10) by a tapered face (42) on a seal body (12). The seal ring (20) has internal annular ribs (52) which are plastically deformed when the seal is set. The material of the seal ring (20) is chosen to give suitable strength and ductility for such deformation, a suitable material being a low alloy Cr-Ni-Mo steel with a carbon content about 0.2%.

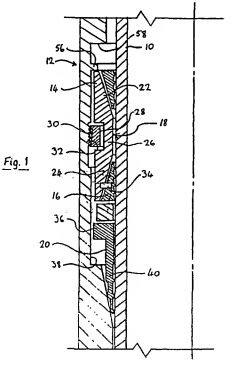

Fig. 1

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METAL SEAL CASING PATCH

This invention relates to a patch for leaks or defects in oil-well casing.

Casing patches in use hitherto have relied on elastomeric materials or lead. The long-term reliability of such materials have been subject to severe doubt, so much so that the use of casing patches on production casings has stopped until a more effective, long-lasting seal might be developed.

The difficulties seen with prior art patches are that the materials used could be damaged by corrosive fluids, and lead seals could be extruded by high temperatures and pressures. It was felt that these difficulties could lead to well control problems.

Accordingly, an object of the present invention is to provide a casing patch utilising a metal-to-metal seal which provides a high sealing efficiency and a long useful life, and a seal ring for use in such a patch.

The invention in one aspect provides a casing patch comprising a generally cylindrical body for positioning over the end of a cut casing, means within the body for gripping the casing, and a seal ring which in use is interposed between the body and the casing; the seal ring being formed to provide a plurality of internal ribs encircling the casing; and the body shaped such that axial force applied to the body produces a compressive force on the seal ring; the seal ring being of a metal having a strength and ductility such that said compressive force produces plastic deformation of said ribs.

From another aspect, the invention provides a seal ring for use in the patch defined in the foregoing paragraph, the seal ring comprising a generally cylindrical body having an internal surface formed with a plurality of encircling ribs.

An embodiment of the invention will now be described, by way of example only, with reference to the drawings, in which:-

Fig. 1 is a longitudinal cross-section of one-half of a casing patch embodying the invention;

Fig. 2 is an enlarged view of part of the assembly of Fig. 1;

Fig. 3 shows a seal ring of Fig. 2 in greater detail.

Referring to Fig. 1, an oil-well casing to be patched is shown at 10. It should be noted that Fig. 1 is schematic only, and the radial dimension has been exaggerated for ease of illustration. As is known per se , the procedure is to cut the casing at a point below the defective zone, withdraw the casing above the cut, and insert a patch assembly down-hole to engage with the remaining casing, the patch assembly being run on the bottom end of replacement casing.

Optionally, the cut edge of the casing may be bevelled and smoothed before the patch assembly is inserted.

The patch assembly of Fig. 1 comprises generally a cylindrical body 12 within which are contained an upper slip 14, a lower slip 16, a slip sleeve assembly 18, and a seal ring 20.

The slips 14 and 16 are formed with inwardly facing teeth inclined as shown such that, when set, the slips 14, 16 grip the casing 10 to resist relative movement in both directions. The slip sleeve assembly 18 provides an upper slip sleeve 22 and a lower slip sleeve 24 each of which abuts its respective sleeve in a part-conical face, and a central portion 26 mounting a C-ring 28 which has an outwardly directed ratchet 30 cooperating with ratchet teeth 32 formed in the body 12. The lower slip 16 is initially secured to the lower slip sleeve 24 by shear pins, one of which is seen at 34, but otherwise the slips 14, 16 and sleeve assembly 18 are axially movable within the body 12 and relative to each other.

The seal ring 20 (see also Fig. 2) comprises an upper ring portion 36 slidable within a cylindrical bore 38 of the body 12 and a tapered lower portion 40, described in greater detail below, cooperating with a tapered surface 42 of the body 12. The upper ring portion 12 terminates in an annular shoulder 44 for cooperation with a stop shoulder 46 in the body 12. A stop ring 48 is positioned between the seal ring 20 and the lower slip 16 and slip sleeve assembly 18.

Referring particularly to Figs 2 and 3, the lower portion 40 of the seal ring 20 on its inner surface has a reducing shoulder 50 and three annular ribs 52 of triangular cross-section, while the outer surface is reduced at sloping shoulders 54 in the proximity of the upper ribs 52.

In use, the assembly is lowered over the cut end of the casing 10. The casing enters through the lower slip 16, whose i.d. should be slightly larger than the casing o.d., for example 13 1/2 inch for 13 3/8 inch casing. The upper slip 14 has an i.d. equal to the casing nominal o.d. As the casing 10 enters the upper slip 14, the upper slip sleeve 22 is retained by a retaining rib 56 in the body 12 while the slip 14 is free to move axially up to a shoulder 58, thus allowing the casing 10 to pass through.

Once the casing is fully entered, upward pull is exerted on the patch assembly. This engages the upper slip 14 with the upper slip sleeve 22, causing the upper slip 14 to tighten and engage on the

casing 10. Further upward force pulls the tapered surface 42 onto the seal ring 20 until the shoulders 44 and 46 engage. During this movement, the ratchet teeth 32 snap over the C-ring ratchet 30, preventing unloading of the seal if the tension of the pull is relaxed. Thereafter, continued loading breaks the shear pins 34 to set the lower slip 16.

The seal ring 20 is of a material which is resistant to temperature effects and well fluids, and has acceptable strength and good ductility. The invention is based on the use of a metal-to-metal seal in which the seal ring deforms and the internal ribs 52 flow plastically into imperfections on the surface of the casing o.d., such as scratches and tong marks, and voids caused by ovality and lack of concentricity are filled. Presently preferred materials for this purpose are low alloy steels. A particularly preferred material is low alloy Cr-Ni-Mo steel with carbon content of 0.18-0.23%, to SAE 8620. Other materials having similar hardness, strength and ductility may be used.

The use of annular ribs which are sufficiently narrow to deform plastically at the loads applied produces a wiping action across the casing o.d. to fill imperfections. It is believed that three ribs will be optimal, but a smaller number may be satisfactory, or a larger number may be required for some uses. The rib cross-section may be substantially triangular, as shown, or may be of other configurations such as part-circular. It is desirable that the ribs initially make a line contact with the casing. The use of external "bumps" such as the sloping shoulders 54 is also a preferred feature of the invention. These distribute the load from the tapered face 42 in such a manner as to stress the ribs 52 and encourage plastic flow. The outer face of the seal ring lower portion 40 will also undergo plastic deformation to form a face-to-face seal with the body 12.

The embodiment described is a dual patch, that is it locks against relative movement between patch and casing in both directions. This is desirable as the patch can withstand thermally induced movements in the casing string without affecting the load setting the seal. In some circumstances, however, a single-direction patch may be used.

The operation described above is suitable for a land well. Where a subsea wellhead is concerned, if the patch is run on new casing which must have a hanger seated in the wellhead, it will be necessary to set the seal by running a casing spear, latching onto the old casing stub and stretching it into the patch, and releasing to use the stretch load to set the seal.

Modifications and improvements may be incorporated without departing from the scope of the invention.

Claims

1. A casing patch comprising a generally cylindrical body for positioning over the end of a cut casing, means within the body for gripping the casing, and a seal ring which in use is interposed between the body and the casing; the seal ring being formed to provide a plurality of internal ribs encircling the casing; and the body being shaped such that axial force applied to the body produces a compressive force on the seal ring; the seal ring being of a metal having a strength and ductility such that said compressive force produces plastic deformation of said ribs.

2. A casing patch according to Claim 1, in which the gripping means comprises oppositely-directed upper and lower slips each having an internal toothed surface for gripping the casing and a part-conical external surface for cooperation with a respective slip sleeve.

3. A casing patch according to Claim 2, in which the upper and lower slip sleeves form part of a sleeve assembly connected to the patch body via ratchet means.

4. A seal ring for use in the casing patch of Claim 1, the seal ring comprising a generally cylindrical body having an internal surface formed with a plurality of encircling ribs.

5. The seal ring of Claim 4, in which said ribs are annular and have a cross-section to provide a line contact with a casing when fitted thereon.

6. The seal ring of Claim 4 or Claim 5, in which the wall thickness of said generally cylindrical body reduces towards one end thereof.

7. The seal ring of Claim 6, in which the wall thickness is reduced by steps in the external surface, one said step being provided in the proximity of each rib.

8. The seal ring of Claim 6 or Claim 7, in which the other end is formed to provide an axially directed shoulder for engagement by a shoulder on the casing body.

9. The seal ring of any of Claims 4 to 8, formed of a low carbon alloy steel.

10. The seal ring of Claim 8, said steel being a chromium-nickel-molybdenum steel with a carbon content of 0.18 to 0.23%.

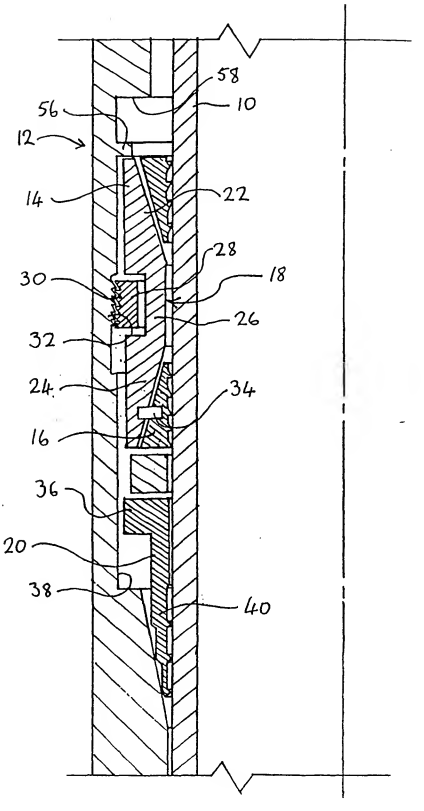

Fig. 1

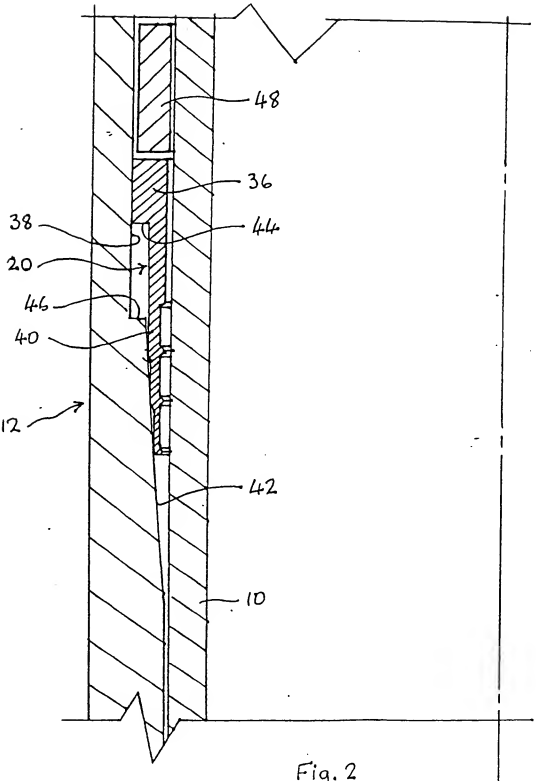

Fig. 2

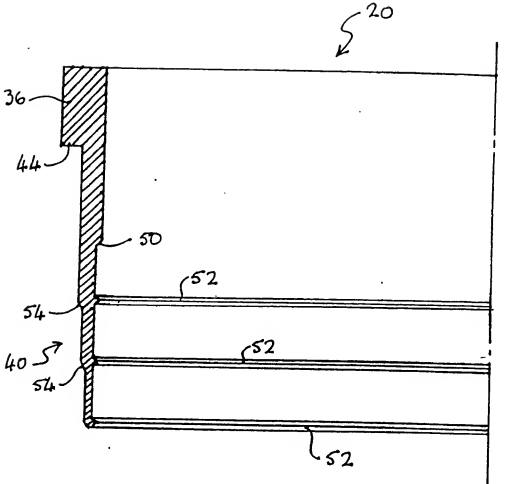

Fig. 3

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EUROPEAN SEARCH REPORT

Application Number

EP 90 30 9981

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
A	US-A-3 865 408 (C.R.YOUNG) * column 4, line 29 - column 5, line 23; figures 2b, 6b *	1,2	E 21 B 29/10 E 21 B 17/02 E 21 B 33/10
A	EP-A-0 289 105 (CAMERON IRON WORKS) * abstract *	4,5	

TECHNICAL FIELDS SEARCHED (Int. Cl.5)

E 21 B

The present search report has been drawn up for all claims

Place of search	Date of completion of search	Examiner
The Hague	12 December 90	RAMPELMANN K.

CATEGORY OF CITED DOCUMENTS

X: particularly relevant if taken alone
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